CONCORDANCERS AND DICTIONARIES AS PROBLEM-SOLVING TOOLS FOR ESL ACADEMIC WRITING

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The present study investigated how 6 Korean ESL graduate students in Canada used a suite of freely available reference resources, consisting of Web-based corpus tools, Google search engines, and dictionaries, for solving linguistic problems while completing an authentic academic writing assignment in English. Using a mixed methods design, the study examined the processes and outcomes of combined use of concordancers and other reference resources by the participants and their perceptions of the reference suite as a means of writing assistance.

Results showed that while the reference suite served as an effective cognitive tool extending the cognitive powers of the participants in solving lexical and grammatical problems, the individual resources in the suite were each shown to have unique functions for which they were best suited, suggesting that concordancing may optimally be consulted in combination with other resources. However, some participants also experienced difficulties in using the tool stemming largely from the nature of their writing tasks and writing stages, and different goals and needs arising from them. This paper concludes by discussing theoretical and pedagogical implications of the findings.

Keywords: Writing, Corpus, ICT Literacies, Human Computer Interaction.

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INTRODUCTION

The digital age we live in has seen a proliferation of online language reference resources for foreign and second language (L2) writers. Specifically, advances in data processing power and storage capacity have not only made traditional reference resources (e.g., dictionaries) available online, often complemented with varied additional linguistic information that cannot be provided in offline resources, but also generated new types of reference resources that support L2 writers in ways that the more traditional resources cannot (Frankenberg-Garcia, 2005; Tono, 2013).

Concordancing (or corpus consultation), one of the new breeds of reference resources, has been getting growing attention as a tool for effectively providing typical and frequent patterns in which a linguistic item is used, extracted from naturally occurring language data (Hyland, 2003; Johns, 1991). While corpora have been steadily explored as language learning resources since the 1980s, it is only in the last decade that concordancing has started to be empirically examined as a reference resource for L2 writing, particularly in university settings (e.g., Gilmore, 2009; Kennedy & Miceli, 2010; O'Sullivan & Chambers, 2006; Park, 2010; Yoon, 2005, 2008). More recently, researchers working in the growing area of Google assisted language learning (GALL) have investigated Google as a handy concordancing tool for L2 writers (e.g., Conroy, 2010; Fujii, 2007; Hubbard, 2005). These studies, on the whole, conclude that if strategically used, concordancing can be an effective tool to aid L2 writers in solving lexical and grammatical problems encountered while writing in their target language.

Despite the emphasis on content and idea development in writing under the influences of process-oriented

writing pedagogy and research, especially in North America, accuracy and appropriateness in written form are still given great importance in the professional and academic world and are often a major factor that affects instructors' assessments of students' writing (Canagarajah, 2002; Hegelheimer, 2006; Yoon, 2008). L2 writers, even at advanced levels, struggle in terms of accurate and appropriate use of vocabulary and grammar (Hinkel, 2002; Silva, 1993) but writing support for these aspects are normally not sufficient (Conroy, 2010). Given that reference resources are often the only sources from which L2 writers can get immediate support for addressing problems in language features as they arise, the addition of concordancing to their existing reference resources may equip L2 writers with an effective problem-solving tool and help them become more autonomous writers.

Concordancing as a Reference Tool for L2 Writing

Concordancing as a pedagogical tool has typically been associated with data-driven learning (DDL) (Johns, 1991), which entails learners taking the role of a researcher to work out the rules and regularities of specific linguistic items using concordance data, often with explicit language learning goals (for a detailed discussion of DDL, see Boulton, 2010). More recently, some researchers (Rüschoff, 2003; Park, 2010) have approached learner concordancing from the perspective of a cognitive tool that extends learners' cognitive abilities (Jonassen, 1992; Norman, 1993) and suggested that corpus consultation can help learners solve immediate problems arising during an L2 task.

With specific reference to L2 writing, Hyland (2003) classified the uses of concordancing into two categories depending on the role played: a *research tool* with which L2 writers can systematically investigate a specific linguistic item or phenomenon and infer underlying rules and a *reference tool* that L2 writers can consult to find immediate solutions to linguistic problems encountered when composing.

Although there is much overlap, concordancing in these two roles has been explored in different ways in previous research. The research tool approach has been examined largely in the form of DDL activity facilitating the learning of specific lexical items, grammatical structures, or genre features (e.g., Cresswell, 2007; Lee & Swales, 2006). Meanwhile, concordancing as a reference tool has been treated as more of a problem-solving tool that aids L2 learners in successful completion of their writing tasks at hand without necessarily involving explicit language learning goals. Many of the recent studies of concordancing for English for Academic Purposes (EAP) and L2 writing examined the latter line of concordancing.

I will briefly review previous research on concordancing as a reference tool and more broadly reference resource consultation. The review starts with the concept of *cognitive tool* as a theoretical basis.

Concordancing as Cognitive Tool

Jonassen (1992) defined cognitive tools as technologies that extend and reorganize the cognitive functioning of users, thereby facilitating their knowledge construction and meaning making. However, this facilitative role played by cognitive tools does not mean that they possess inherent cognitive powers themselves. It is still the human user that engages in noticing, inducing, and drawing conclusions (Wolff, 1997). In other words, "cognitive tools enable mindful, challenging learning, rather than the effortless learning (Jonassen & Reeves, 1996, p. 698).

These characteristics of cognitive tools can also be attributed to concordancing (Rüschoff, 2003; Wolff, 1997). Concordancers sort and display language data in ways that allow users to discover patterns, test hypotheses, and figure out solutions to language problems at hand. These higher-order cognitive activities would not be possible or would take much more time and cognitive effort if done by users alone. Yet, concordancers do not analyze language data. It is the users who do the decision making and problem solving at every stage of analysis while the concordancing tool helps them overcome the limitations of their mind on memory and computing. This "intellectual partnership" between the user's mind and cognitive tools (Salomon, Perkins, & Globerson, 1991, p. 2) can be seen as a form of distributed

cognition between the human mind and cognitive artifacts (Park, 2010).

Previous Empirical Studies

Empirical research in concordancing as a reference resource can be grouped roughly into four strands. The studies in the first strand typically involved one-time classroom tasks after a period of training. The participants consulted corpora while correcting errors in given writing samples or revising them based on corrective feedback or on their own. These studies demonstrated that concordancing may help learners notice and learn lexico-grammatical patterns, especially the usages of prepositions and idiomatic expressions (Chambers & O'Sullivan, 2004; O'Sullivan & Chambers, 2006), and enhance the naturalness of the text that users produce (Gilmore, 2009). At the same time, some participants often failed to discern the unique functions of corpus tools and could not exploit the tools as intended (Kennedy & Miceli, 2010).

The second strand of studies traced how L2 writers used corpus tools during their authentic writing assignments lasting a semester or longer. It was found that corpus consultation during L2 composition over time seemed to increase lexico-grammatical awareness and performance of participants by providing them with scaffolding through "dialogic negotiation" (Park 2010, p. 160). It also fostered writer autonomy by allowing the participants to take greater responsibility for their writing (Yoon, 2008). However, there were still some participants who failed to perceive the affordances of the corpus tool provided and did not use it in intended manners or as often as expected (Hafner & Candlin, 2007). Based on the mixed findings, it was suggested that the extent and purposes of corpus consultation while writing are largely determined by the needs of the writers arising from the disciplinary or professional context for which they write (Hafner & Candlin, 2007; Yoon, 2008).

The studies in the third group explored Google as a concordancer. The common rationale for using Google was that it was both easy to use and familiar to most learners while providing a huge amount of authentic language data from the Web. Positive effects of Google use identified in these studies were, among others, increased accuracy and naturalness of L2 writers' text (Fujiji, 2007), facilitation of written error corrections (Watson Todd, 2001), and a greater sense of independence in L2 writing (Conroy, 2010). However, some caveats have also been raised regarding the use of Google as a linguistic reference resource. Because of the heterogeneity of Web contents in terms of variety, genre, and register, and the considerable amount of lexical and grammatical errors contained on the Web, Google may pose challenges to L2 writers in academic settings, for which accurate and appropriate text production is crucial (Wu, Franken, & Witten, 2009). Mindful of this limitation, some researchers have used more specialized Google services that retrieve search results only from academic publications or pre-designated Web sites, such as Google Scholar (Brezina, 2012) and Custom Search Engine (Park, 2010).

Lastly, a small number of studies (e.g., Kennedy & Miceli, 2010; Lai & Chen, 2015) looked directly into how their participants consulted different types of reference resources during L2 composition. These studies offered some common findings: (a) participants used different resources for different purposes (e.g., dictionaries for word form and meaning, and corpora for word usage) and (b) some participants used different resources strategically in complementary manners, starting with one resource and expanding on it with another.

One final issue to consider is the types of corpora used in these studies. Research on corpus use in academic writing has shown growing interest in specialized corpora that are highly relevant to the genres and disciplines in which learners have to write and thus cater to L2 writers' needs more directly (e.g., Hafner & Candlin, 2007; Kennedy & Miceli, 2010; Lee & Swales, 2006). For example, in a specially designed EAP course for doctoral students, Lee and Swales (2006) examined how four English as a second language (ESL) doctoral students gradually familiarized themselves with the "'corpus' way of investigating language" (p. 60), particularly in terms of conventions of disciplinary writing while using corpora of academic discourses. However, despite their proven and potential benefits, specialized corpora

have not been widely adopted in research and classroom application yet, mainly for practical reasons (Charles, 2014; Park, 2010; Yoon, 2008). First, many of these genre- or discipline-specific corpora were compiled for individual academic writing courses or research projects, and as such are often unavailable to outside users. Second, compiling one that is large enough is time-consuming and requires sufficient knowledge and skills. For these reasons, readily available general purpose corpora such as the British National Corpus (BNC) and the Collins COUBUILD Corpus (or the Web as a corpus) have often been used in the majority of the studies.

Present Study

The studies reviewed above provide valuable insights into the potential of concordancing as a means of writing assistance. Nonetheless, many of these studies are confined to examining one-off timed written error correction or revision tasks, mostly in classroom settings, with a concordancing tool provided as the only or main resource to consult.

To expand the scope of inquiry to a more typical and authentic setting for L2 student writers, the present study traced how six Korean ESL graduate students in a Canadian university independently used a suite of freely available online language reference resources (consisting of concordancers and dictionaries, each of which is described below) over the entire course of completing an authentic writing assignment (e.g., a term paper or a research proposal). It especially examined the potential of the reference suite as a cognitive tool that extends the cognitive powers of L2 writers and mediates their problem solving while writing. The present study situated the use of reference resources in a context where the participants engaged in one of their real-world writing assignments with all their contextual complexities and constraints (as opposed to writing tasks designed for research purposes). In addition, other useful reference resources were provided along with the concordancers, reflecting the wide real-life choice today's L2 writers have regarding reference resources to consult. Several participants had already been using some of these resources for years. The focus here was to examine how concordancing tools can be consulted in combination with other resources as a whole rather than investigating whether one resource is better than another.

The present study was specifically guided by the following research questions:

1. How and for what purposes do the participants consult the reference suite?
2. How does the use of the reference suite affect the participants' problem-solving performance?
3. What are the strategies used and pitfalls encountered by the participants in their interactions with the suite?
4. How do the participants evaluate concordancers and other resources in terms of their utility as writing support tools?

METHODS

Participants

A total of six Korean ESL graduate students residing in Toronto, Canada, participated in the study. The rationale for having this specific group of participants was as follows: First, graduate students are likely to have the levels of cognitive skills and linguistic knowledge required to use sophisticated search options in some of the reference resources (see below). They are also assumed to be willing and motivated to invest time and energy in improving their writing performance using a reference tool for their academic success and career advancement. Second, by sharing the same L1 (Korean) with the participants, I would be able to directly observe and analyze participants' natural writing and linguistic problem solving, if any, that involves both textual and conceptual L1-L2 translation. Table 1 presents profiles of the six participants.

Table 1. *Participant Profiles*

	Jae	Yumee	Jinho	Goeun	Shia	Ian
Gender	Male	Female	Male	Female	Female	Male
Age	37	28	24	29	34	31
Degree pursued,field of study	PhD, Adult Education & Human Resources	PhD, Educational Technology	MA, Information Studies	PhD, Language Assessment	MA, Social Work	PhD, Second Language Education
Prior experience with corpus tools	None	None	None	COCA	None	None
Writing assignments	Conference paper	Research proposal	Term paper	Term paper	Term paper	Research proposal
Approximate duration of participation	18 weeks	20 weeks	16 weeks	12 weeks	7 weeks	16 weeks

Note. All participant names are pseudonyms

The participants were all from writing-intensive disciplines. Four were doctoral students from the broad discipline of education and two were master's students: one in information science and one in social work. None of the participants had prior experience using corpora and concordancing tools, except Goeun.

Reference Suite (RS)

RS (also referred to as "the suite" hereafter) is a mini Web browser developed for the study. It allows a user to access eight different language reference resources (five concordancers including Google search engines, and three types of dictionaries) that are freely available on the Web. RS allowed access to these resources in a single interface, making it easier to move back and forth between multiple resources on the same window. Every query performed in the RS search box (see Figure 1) was automatically recorded in a query log. With the query log program running in the background, participants could, by and large, consult the tool without much interruption.

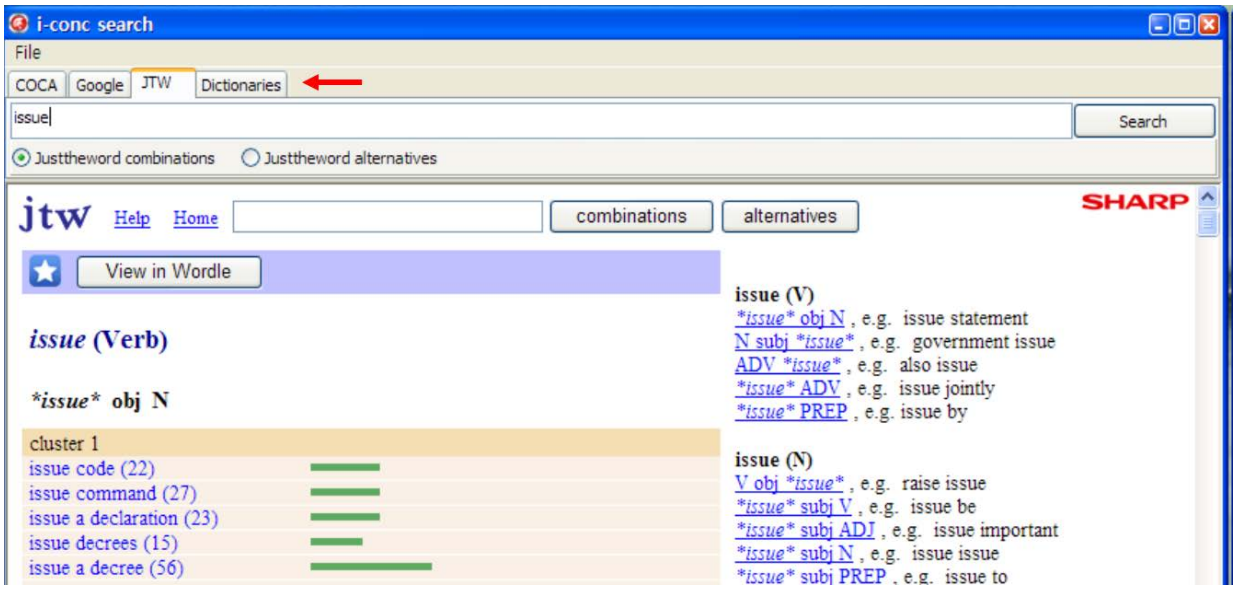

Figure 1. A screenshot of RS. This specific screenshot shows the search results of the query *issue* performed on JustTheWord (JTW).

Multiple concordancers were provided in RS to examine how and for what purposes the participants would use different concordancers in terms of their size, part-of-speech (POS) tagging, features, and options provided. These concordancers were accessed on the first three tabs (see the arrow in Figure 1). The first tab linked to the Corpus of Contemporary American English (COCA), a 450 million-word POS-tagged corpus and its concordancing interface. Not only does COCA contain various genres of text, including an academic subsection, but it also provides the most varied and sophisticated search options. However, these sophisticated search options require the use of query syntax that takes some time to learn and get used to. On the second tab, *Google*, three different Google search engines were accessed. Unlike the two other concordancers featured in RS, these Google search engines retrieved data from the Web—huge in size but not POS-tagged, therefore not allowing sophisticated search refinement options. Google was one of the most familiar resources to the participants and one of the easiest for them to use. However, it may have posed some challenges to learners due to the heterogeneity of its language data. Google Scholar (GS) and Custom Search Engine (CSE)[1] were added to compensate for these possible weaknesses of Google as a language reference. Along with the academic subsection of COCA, these two resources helped meet the needs of graduate academic writing by allowing the users to confine their searches to academic registers in general (GS) or to a particular domain or academic field (CSE). Finally, JustTheWord (JTW) was an easy-to-use concordancer that did not require the use of query syntax. However, it ran on a relatively small POS-tagged corpus (an 80 million-word subsection of the BNC). Simply typing in a word in this resource retrieved from the source corpus all the collocational combinations the word made and displayed them in highly organized manners.

The last tab was dedicated to three types of online dictionaries: Naver (an online bilingual Korean-English, English-Korean dictionary), LDOCE (an online version of the *Longman Dictionary of Contemporary English*), and Thesaurus (*Roget's 21st Century Thesaurus*). Table 2 summarizes the major characteristics of the eight resources described above.

Table 2. *Reference Resources Accessed in Reference Suite*

Tab name	Resource name and URL	Description
COCA	Corpus of Contemporary American English http://corpus.byu.edu/coca/	The largest corpus/concordancing interface freely available on the Web. POS-tagged Offers many features and options Requires the use of query syntax for sophisticated searches
Google	Google Web http://www.google.com	Powerful concordancer using the entire Web as its corpus Provides rich but highly heterogeneous data posing challenges to language learners
	Google Scholar (GS) http://scholar.google.com	Retrieves data from academic publications
	Custom Search Engine (CSE) http://www.google.com/cse	Retrieves results only from the designated sites and URL patterns Enables domain- or field-specific searches
JTW	JustTheWord http://www.just-the-word.com	POS-tagged Shows all the combinational relationships the queried word has with other words
Dictionaries	Naver (bilingual) http://endic.naver.com	Online Korean-English bidirectional dictionary
	LDOCE (monolingual) http://www.ldoceonline.com/	Online version of Longman Dictionary of Contemporary English
	Thesaurus http://www.thesaurus.com	Online Roget's 21 Century Thesaurus

Procedures

The present study was conducted in two phases. In the first, exploratory phase, the participants filled out an initial survey and had an interview about their approaches and attitudes toward English academic writing and their uses of reference resources. Next, they received three hours of individual tutoring from me, which covered basic corpus linguistics concepts, the purposes for which each resource in RS can be consulted, and strategies for their effective use. After using RS for a few weeks independently whenever they needed to consult reference resources, the participants recorded their uses of the suite for an hour using a free screen-recording software (BB Flashback) installed on their computer. While watching the screen-recorded videos together, I provided each participant with feedback on how to improve his or her RS consultation.

In the second phase of the study, the participants chose a major writing assignment (10 pages or longer) they were required to complete either for an academic course they were taking or as part of their degree requirements (e.g., a term paper or a research proposal) and were asked to consult RS while working on their chosen assignment. The users were instructed to use RS as was suggested in the tutoring and to address the feedback they received in the first phase. While working on their assignment, they recorded their writing processes using screen capture software at their convenience. Three sessions of about one hour were recorded: two at the drafting stage and one at the editing or proofreading stage. Each screen

recording was followed by a stimulated recall session conducted within two days of recording, in which the participants shared their intentions behind each query and decision they made. Lastly, the participants had a final interview and filled out an evaluation survey in which they shared what they perceived as the advantages and disadvantages of using the tool for their academic writing. The instructions for each step were provided in person and also electronically with detailed guidelines.

All these procedures were conducted individually with each participant, so the duration of data collection (the first and second phases combined) varied depending on the participant, ranging from seven weeks to 20 weeks. This wide difference was caused mainly by different types of writing assignments the participants completed for the study (see Table 1) and their varied time availability for the assignments.

Data Analysis

To answer the research questions (RQs), multiple analyses were conducted. For RQ 1 regarding how and why the participants consulted RS, I segmented the collected data into units of analysis, or *problem spaces*[2]. In this study, a problem is defined as a linguistic question arising while writing that prompts a reference resource consultation. A problem can be resolved (or abandoned) with one or more look-ups in the suite. A problem space in this study, then, refers to all of the look-ups or *queries* the writer performed for the resolution of a problem using RS. To identify the process and purposes of each problem-solving incidence identified, I developed a coding scheme based on previous research (Frankenberg-Garcia, 2005; Kennedy & Miceli, 2010; Park, 2010; Roca de Larios, Manchón, & Murphy, 1996) and a preliminary analysis of the first-phase data. First, problems were classified into two types: *confirmatory* and *compensatory*. Confirmatory problems refer to instances where writers tried to confirm the accuracy or appropriateness of a certain linguistic item they already had in mind or in writing in terms of its match with the intended meaning or context. Compensatory problems refer to instances when writers tried to extract a linguistic item from the reference resources that could express the intended meaning accurately and appropriately. Second, queries were classified into two types according to the format of the question that motivated a look-up in RS. A *verification* query is prompted by a closed-form question writers pose (i.e., yes or no questions, see Kennedy & Miceli, 2001). A sample verification question could be, "Is the adverb *deeply* the most typical collocate of the word *entrenched*?" An *elicitation* query is prompted by an open-form question (i.e., a "what" or "how" question). For example, a participant might ask, "What are the typical adverbs that modify the word *entrenched*?" Last, queries were classified according to the content of the question into 14 different purposes such as *finding or checking a collocate* and *finding an L2 equivalent*. The definitions and examples of the categories described above are provided in Appendix A.

To answer RQ 2 concerning the effects of RS consultation on problem solving, each problem space identified was coded on two dimensions: (a) *positive* or *negative* depending on whether the RS consultation resulted in a correct text formulation or revision, and (b) *satisfied* or *dissatisfied* depending on whether the writer was satisfied with the consultation results—that is, whether he or she perceived the given problem as successfully solved. I coded the data on these two dimensions to examine how successfully the participants carried out RS consultations and how it compared with their own perceptions of the consultation results.

For RQ 3, I contrasted what the participants said they intended to do with RS with what they actually did with it. For RQ 4, about the participants' evaluations of the tool, the initial and final surveys and interviews as well as informal interviews conducted at the end of stimulated recalls, were analyzed through several iterations of thematic coding.

To establish reliability of the analysis, two additional coders—both PhD students in second language education—participated in the coding. Each problem and query identified was assigned a unique ID number and 20% of them were randomly selected. After having an individual practice session, one of the coders independently coded the randomly selected 20% for problem type, query type, and query purpose.

The other coder likewise coded 20% of the problems for the effects of RS consultation on problem solving. The inter-coder agreements were high: 100% for problem type and 93%, 91%, and 84% for query type, purpose, and effect on problem solving, respectively. Since only 20% of the data was checked, no attempt was made to resolve the disagreements.

RESULTS

RQ 1: How and why do the participants consult RS?

Analysis of problems and queries

During the study period, the participants carried out a total of 3,170 queries. Of those, 515 queries were screen-recorded during the participants' self-chosen writing assignments and recalled within a few days. Findings presented below come from the analysis of these 515 queries.

Through the 515 queries, the participants attempted to solve a total of 245 problems, performing an average of 2.1 queries per problem space (see Appendix B for an example of a problem space and the consultation sequence within it). Out of 245 problems, 142 problems (about 58%) were confirmatory (i.e., testing an intuitive hypothesis made based on the problem solver's existing knowledge) while 103 (about 42%) were compensatory (i.e., extracting linguistic items that were inaccessible by the problem solver from RS). At the query level, the participants carried out more verification queries seeking answers to *whether* questions than elicitation queries for *what* or *how* questions at a ratio of 3:2 (see Table 3). These results suggest that the participants consulted RS to confirm their existing linguistic knowledge more often than to seek linguistic items that were beyond their current linguistic repertoires.

Table 3. *Analysis of Problems and Queries*

Types			Purposes					
Problems	f	%	Initial query	f	%	Subsequent query	f	%
(*N* = 245)			(*N* = 245)			(*N* = 270)		
Confirmatory	142	58	Collocation	52	21.2	Simple confirmation	86	31.9
Compensatory	103	42	L2 equivalent	44	18.0	Intended meaning	10	25.9
			Simple confirmation	40	16.3	Collocation	43	15.9
Queries	f	%	Intended meaning	38	15.5	Register	24	8.9
(*N* = 515)			Upgrading	27	11.0	Upgrading	16	5.9
Verification	317	61.6	alternative			alternative		
Elicitation	209	40.6	Register	15	6.1	General usage	15	5.6
			Simple alternative	15	6.1	Simple alternative	15	5.6
			Argument pattern	11	4.5	L2 equivalent	12	4.4
			General usage	8	3.3	Argument pattern	6	2.2
			Noun ending	8	3.3	Part of speech	5	1.9
			Article/determiner	6	2.4	Sentence/phrase	5	1.9
			Part of speech	3	1.2	hunting		
			Sentence/phrase	3	1.2	Article/determiner	3	1.1
			hunting			Noun ending	1	0.4
			Spelling	2	0.8	Others	7	2.6
			Others	7	2.8			

Note. A considerable portion of the queries were classified into more than one category, so the sums of the percentages exceed 100%.

Turning to the purposes for which the participants consulted RS, findings were presented separately for initial queries and subsequent queries. An initial query (i.e., the first query within a problem space) was considered primary, as it showed the initial motivation that prompted an RS consultation. Therefore, the content of the problems the writers addressed using RS can be inferred from the initial query purposes. Subsequent queries within problem spaces were considered secondary, as they were performed to build on the previous query results (see Appendix B for examples). For initial queries, the participants consulted RS for *collocation, L2 equivalent,* and *simple confirmation* most frequently (see Appendix A for a detailed description of each query purpose). When it came to subsequent queries, the participants were shown to expand on the previous query results or get corroboration through queries for *simple confirmation*, *intended meaning*, *collocation,* and *register* (see Table 3).

Resources Consulted

Over the course of completing their writing assignments, the participants most frequently consulted Naver and COCA, performing 25.6% and 25.4% of their queries in each resource, respectively. Google was a relatively close third (18.1%), followed by JTW (11.1%), LDOCE (7.8%), and Roget's Thesaurus (5.2%). CSE and GS ranked lowest and were consulted for less than 5% of total queries.

Table 4. *Major Purposes for which each Resource was Consulted*

Resource	Consultation frequency (N = 515)	%	Major purposes	% within each resource
Naver (Bilingual)	132	25.6	L2 equivalent	41.7
			Intended meaning	27.3
			General usage	9.8
COCA	131	25.4	Collocation	35.9
			Intended meaning	20.6
			Simple confirmation	14.5
			Upgrading alternative	14.5
Google	93	18.1	Simple confirmation	78.5
JTW	57	11.1	Collocation	59.6
			Intended meaning	15.8
			Upgrading alternative	15.8
LDOCE (Monolingual)	40	7.8	Intended meaning	70.0
			Collocation	12.5
			Noun ending	10.0
Thesaurus	27	5.2	Simple alternative	48.1
			Upgrading alternative	33.3
			Intended meaning	18.5
GS	18	3.5	Simple confirmation	55.6
			Register	50.0
CSE	17	3.3	Register	88.2
			Simple confirmation	58.8

Note. Percentage figures in this column represent the percentages of the given purposes within each resource. Many queries were performed for more than one purpose, so the sum of percentages within each resource exceeds 100%.

A general trend emerged, suggesting that each resource had a unique set of predominant purposes for which it was consulted. For example, the participants preferred to consult Naver for *L2 equivalent*, Google for *simple confirmation*, and COCA and JTW for *collocation* (see Table 4). Another closely related finding was that in about a quarter of the total problem spaces, the participants consulted different resources in combination within a given problem space to corroborate or expand on initial query results. This overall trend demonstrates that the participants were aware of what information each resource provided and strategically used each resource for a distinct purpose.

RQ 2: How does the use of the reference suite affect the participants' problem-solving performance?

RS consultations proved to be overall helpful to the participants in problem solving during their writing assignments. In 170 problem spaces (69.4%), RS consultation had a positive effect and resulted in a correct text formulation or revision. However, RS use led to an incorrect text, having a negative effect in 31 problem spaces (12.7%). In the remaining 44 problem spaces (18%), the participants abandoned RS consultation due to difficulties finding relevant items from the query results.

The problem-solving performance rates presented above, however, did not necessarily match the participants' perceptions of the consultation results. The participants were dissatisfied with 13 out of the total 170 problem spaces where RS consultation had a positive effect whereas 20 problem spaces ended up with an incorrect text even though the participants perceived them as successfully solved. These mismatches were caused by different factors such as a wrong solution retrieved from the query results or misapplication of the chosen solution to writing.

In terms of problem type, the rate of positive effects from RS consultation was considerably higher with confirmatory problems. Out of a total of 142 confirmatory problems, 109 (76.8%) led to a correct text compared to 61 (59.2%) of compensatory problems. Meanwhile, the rate of abandoned consultations was much higher with compensatory problems (28.2%) than with confirmatory (10.5%). This result demonstrates that the participants had greater difficulties solving compensatory problems than confirmatory problems by consulting the suite.

RQ 3: What are the strategies used and pitfalls encountered by the participants in their interactions with the suite?

As presented above, the participants used the reference suite quite effectively, with RS use contributing to correct text formulation or revision about 70% of the time. To a large extent, this effective use was made possible through strategies the participants employed or developed as they became more familiar with the suite. These strategies can be broadly broken down into *querying* and *evaluation* strategies.

Querying strategies are ones that the participants used for formulating and refining query terms. One commonly used strategy was to use a different resource to expand or build on the previous query. The most common sequence in using this strategy was getting a hint from Naver for an L2 form expressing the intended meaning and then performing an English query on COCA or Google to find its acceptability or frequency. Another common strategy was to perform further queries by refining the query term when the initial query results were not satisfactory. Participants replaced either all or part of the previous query term with an alternative in terms of meaning, POS, or syntactic structure (see Appendix B for an example).

Evaluation strategies, in turn, refer to the strategies the participants used to evaluate query results and apply the solution found to their writing. The most frequently used strategy of this type was utilizing frequency information. Specifically, it involved choosing the most frequent item from multiple alternatives (in an elicitation query), or accepting a certain number of instances of the target item as evidence of its acceptability (in a verification query). Some participants used, though much less frequently, their content familiarity with the items or authority of their data sources as criteria for

choosing the item to apply in their writing.

Despite their overall effective use of the suite, the participants still fell into pitfalls in its use, which contributed to incorrect text formulations or revisions, false perceptions of successful problem resolution, or consultation abandonment. What can be called "lack of rigor" in observing query results (Kennedy & Miceli, 2001, p. 77) was the most common cause for unsuccessful problem-solving outcomes. The participants sometimes simply picked the most frequent item or checked the target item's frequency information but did not check whether it carried the intended meaning or was appropriate in the intended context.

The second pitfall commonly observed was lack of flexibility in trying out different options. The participants missed out on opportunities to reach better solutions or the same solutions more effectively by fixating on certain ways of representing problems and on only one or two resources for most of their queries. For example, some participants showed a strong preference for verification over elicitation even for problems for which elicitation queries would have been more helpful. In one of her problem spaces, Yumee carried out a verification query of *made its identity* on Google to see if the verb *make* can be a good collocate of the noun *identity*. Her intended meaning was *develop its identity*. She could have found appropriate and alternative collocates including *develop, establish,* and *create* by querying *identity* on JTW or COCA.

The last pitfall stemmed from the limitations of the resources themselves. For example, Google sometimes returned a considerable number of hits for even an ungrammatically formulated query term, giving the participant false confirmation on that queried word or sequence.

RQ 4: How do the participants evaluate concordancing and other resources in terms of their utility as a writing support tool?

Overall, the participants evaluated RS positively. The participants responded that RS provided them with easy access to mutually complementary reference resources from a single interface. Most participants shared the view that the multi-resource consultation capability made it possible to get corroboration on the linguistic items in question from different resources relatively quickly, therefore allowing them to use the solutions they found in their writing with confidence. There were other important benefits of using RS mentioned by the participants. First, the presence of multiple resources motivated the participants to venture beyond their current linguistic repertoires and experiment with new ways of expressing intended meanings, as evidenced by the following remarks from Goeun:

> [RS] allows me to go beyond my current linguistic repertoire (…) to try new ways of expressing my thoughts. (…) I feel like my English is becoming fossilized. With this tool, you can check whether your experimental expressions can actually be used or not. (Final Interview)

Second, the participants became more attentive to the accuracy and appropriateness of the language they used in their writing and increased their lexico-grammatical awareness. Third, these changes combined to increase, if not drastically, their confidence in the linguistic aspects of English academic writing, providing them with a sense of independence as L2 writers. According to Jae:

> [RS] helps me have confidence a lot. In the past I felt helpless, but now I think I can produce, to some degree, refined texts as long as I have time and motivation to use the tool. I would say RS (…) helps users edit their writing on their own. (Final Interview)

However, the participants also experienced various challenges while using RS, especially the concordancers. The first and foremost challenge that all participants shared was the time-consuming nature of RS consultation. Most participants expressed frustration with the time required to go through the consultation cycle, from devising a search strategy to evaluating the results, to find what they were looking for. Some participants found going through the consultation cycle not only time-consuming but

also cognitively taxing, as it required them to make decisions at every step, when much of their attentional resources were already consumed by other various aspects of the writing task at hand. Closely related, some participants also reported that they sometimes became so engrossed in their RS consultations that they had their flow of thoughts interrupted in terms of global content of their writing, especially at the drafting stage. This point was poignantly expressed by Ian:

> (…) what bothered me a little was that it can easily distract you from your writing. You cannot afford to be interrupted while writing down what is shaping up in your head in terms of content. But when I use this tool, I am tempted to use each resource here to confirm the accuracy. (3rd Stimulated Recall)

Another shortcoming of RS expressed by the participants was the nature of interactivity they had with the suite. Jae and Goeun pointed out that unlike getting support from a human tutor or expert, it is still almost solely the user's responsibility to find a solution by feeding the right query terms into the resources and making the correct judgments about the results, and even then there is no guarantee that the solution found is the right one.

As for the advantages and challenges of using each component resource, Naver was received as an all-purpose reference resource with its versatility of functioning as a dictionary, thesaurus, and corpus. In addition, the speed and ease with which it could be consulted was a major contributor to its frequent use among the participants. COCA was considered a concordancer that provided considerable amounts of reliable examples in terms of their sources. Its sophisticated search options and operators allowed some participants to elicit and verify phraseologies and grammar in creative ways. However, the very same use of query syntax and operators in COCA also posed difficulties to other participants. JTW was seen as a simple-to-use but powerful tool for finding and checking collocations, but at the time of collecting data, the participants were frustrated by its frequent crashes due to its unstable server. As for Google, most participants agreed that it was a quick and easy tool in checking the presence and frequency of a word sequence of any length. However, they were not completely sure about the reliability of the linguistic information they retrieved from the Web. The final resources that drew a common response were GS and CSE. The participants all mentioned that these two Google resources were intended for checking the register of given linguistic items but they gradually stopped using them over time as they realized these resources were too small in size to provide sufficient data on which to base their decisions.

DISCUSSION

Concordancing versus Other (More Traditional) Reference Resources

One major thrust of the present study was to explore the utility of concordancing as a reference resource for L2 academic writing. The study results demonstrated that overall, concordancing enabled the participants to effectively solve specific types of problems such as collocation and simple confirmation. At the same time, as in some of the previous studies (Kennedy & Miceli, 2010; Lai & Chen, 2015; Yoon, 2008), concordancing proved to be neither the most preferred resource in terms of frequency of use nor the best suited for many consultation purposes. Rather, the participants were shown to strategically consult each resource (type) for a unique set of purposes, often using multiple resources within a single problem space. As evident in the high rate (69.4%) of positive effects from RS consultation, the pattern of using multiple resources in complementary ways contributed to successful problem solving, lending support to the arguments in previous research in favor of using corpus tools along with, rather than in place of, other reference resources (e.g., Conroy, 2010; Flowerdew, 2009).

By examining this combined use of multiple reference resources, this study provides some important insights into reference resources as a problem-solving tool for academic writing. First, previous studies in similar settings (e.g., Park, 2010; Yoon, 2008) found that learners showed a strong tendency to use the given corpus tools to confirm their existing knowledge rather than to elicit new knowledge on their target

language. In this study, however, the participants tried to perform a considerable number of elicitation queries (40% of all queries), with many of them leading to successful problem solving. This is a welcome finding, as a balanced use of two types of queries seems to enable more effective problem solving and provide greater opportunities for language development (Park, 2010). The greater tendency to pursue compensatory consultation found in this study may be linked to the multiplicity of reference resources and search options and the flexibility to use them in combination in order to meet the writer's ongoing needs. The presence of multiple resources with largely unique functions provided the participants with both motivation and means to carry out different types of queries.

Second, within concordancer-type resources, the extent and frequency of use differed widely depending on the size and tagging status of the source corpus. While the participants used COCA and JTW—both POS-tagged corpora—for finding or checking collocates and alternatives through both elicitation and verification queries, they used Google—running on untagged but abundant language data—mainly for confirming the acceptability of multi-word strings they formulated predominantly through verification queries.

Meanwhile, GS and CSE were consulted the least, accounting for less than 5% of all queries, and were mainly used to check register. This was a somewhat surprising result, as these two search engines had been included in the suite specifically to meet the needs of academic writing and to compensate for the weaknesses of Google. In actual use, however, the participants could hardly afford to explore discipline- or genre-specific textual patterns using these resources as they were working on their papers under pressure with tight deadlines. Even when the participants did use these resources to check whether a certain string was in the right register, GS and CSE often returned no or few hits of the queried item, making the participants dismiss them as too small to be useful. Also worth noting is that some participants, especially PhD students, pointed out that they did not feel much need for a discipline-specific corpus because they had their own content knowledge and readings to turn to for usages of discipline-specific vocabulary. These findings, in sum, imply that GS and CSE would be more usefully consulted as research tools that help writers discover discipline-specific textual patterns and genre characteristics when given sufficient time and motivation as in Lee and Swales' (2006) experimental course. These resources may still be lacking as reference tools that can assist time-constrained writers in finding immediate solutions to problems.

Last, the participants consulted Naver more than any other resource (25.6%), even though the training and feedback during the study were focused on the various, often novel, ways of solving linguistic problems using the concordancers. This frequent use of the bilingual dictionary by the participants can be linked to a few factors. First, the participants performed a higher number of translation queries than expected for students of their academic level. This shows that that they performed a great deal of conceptual and textual L1 to L2 translation. Second, the participants had already been using this resource for years prior to the study, so they knew very well what to query and where to click. Third, Naver was the most versatile resource in RS proving extra linguistic information such as synonyms and collocations. While working on the real-life writing assignments that came with tight deadlines, the participants often turned to this familiar resource that served multiple purposes.

Taken together, the findings suggest that as a reference resource for on-the-fly problem solving during L2 writing (as opposed to a DDL research tool), a concordancer should have a large POS-tagged source corpus so that it allows different types of elicitation queries, and provides sufficient concordances for verification queries. At the same time, it should not be too complicated to operate and fast enough not to interrupt the flow of thoughts of the writer.

Cognitive Extension versus Cognitive Distraction

The main theoretical assumption for the present study was that linguistic reference resources, especially concordancing, can provide L2 writers with an intellectual partnership and extend their knowledge and

thinking during problem solving. By and large, RS was shown to serve as an intellectual partner to the participants through a cognitive division of labor and to enhance their intellectual performance for solving lexico-grammatical problems that arose while writing. To give only the simplest description of the typical division of labor that happened in problem solving, RS provided the participants with lexical and grammatical options that they would not have been able to access instantly, as these items had been neither acquired nor fully internalized (i.e., compensatory problem solving). RS also made it possible to test and readjust their form-meaning mappings (i.e., confirmatory problem solving). As such, the participants and the suite jointly solved linguistic problems in ways that the participants alone would not have been able to do—at least not as effectively.

However, most of the participants also experienced varying degrees of frustration with respect to the cognitive processes involved in using RS. While the reference suite was supposed to amplify their cognition in problem solving as described above, the participants sometimes found the use of the tool to be cognitively taxing. Most of these conflicting perceptions among participants of the current study can be traced back to misalignments between the goals of the participants and the affordances offered by the tool.

The participants were all graduate students whose approaches to academic writing for course assignments and degree requirements typically focused on meaning or content. Therefore, they did not engage in the writing task with an explicit language learning goal. However, the presence and use of RS heightened their awareness of language problems and provided a means to address them on the fly. Sometimes these affordances offered by RS led the participants to focus on linguistic features of writing more than they normally would. It is on these occasions that the main goals of the participants and the affordances of the tool were misaligned and thus RS consultation felt like an extra cognitive burden. This misalignment often took place at the drafting stage of writing, when their attentional resources were mainly focused on content rather than on rhetorical concerns. This resonates with the evaluative comments by some participants in Hafner and Candlin (2007) that using corpus tools made them focus unnecessarily on linguistic structure at the expense of content. In line with the findings from previous research (Hafner & Candlin, 2007; Yoon, 2008), this interpretation strongly suggests that overall educational contexts, the types of writing tasks, stages in the writing process, and the goals and expectations arising from each stage are major factors influencing individual writers' intellectual partnership with and perceptions of reference resources.

Limitations of the Study and Suggestions for Future Research

Although the study shed some new light on the under-researched aspects of learner concordancing and reference resource consultation, there were also some limitations. First, the study was based on only a small number of the participants, so the findings can hardly be generalized to larger groups of L2 writers. Another, related limitation is that while this study focused on the general trends emerging from this small group of L2 writers, many of the findings were presented as group findings, obscuring possible individual differences among the participants.

Acknowledgment of the limitations above leads to suggestions for future research. First, the study can be extended to larger and more various groups of L2 writers with more sophisticated research designs. One specific avenue for further research would be to systematically investigate how reference resources are consulted by L2 writers in different stages of the writing process (e.g., drafting vs. revising). Another suggestion would be, as one of the reviewers of this paper suggested, to conduct a large-scale study that compares one group of students using only their usual reference resources, such as a bilingual dictionary, with another group using a suite of mutually complementary resources.

CONCLUSION

The findings of this study suggest that using concordancing tools along with other complementary

reference resources within a single interface may provide advanced L2 writers in academic settings with means and motivation to engage in robust meaning negotiations during their L2 written language production and therefore ultimately help them become more confident and autonomous as writers. However, as evident in the various cognitive, affective, and technical forms of challenges and difficulties the participants experienced in their uses of the reference suite, effective and meaningful uses of reference tools should be preceded by appropriate training and guidance.

In this regard, it seems appropriate to conclude this article by making a few suggestions for learner training. A synthesis of the findings of the present and previous studies indicates that there is a number of principles to bear in mind. Firstly, learner training should be progressive and contingent on the abilities and traits of individual learners, reference resources available, and ongoing needs arising from their writing contexts. Secondly, this training should be provided in ways that students can directly connect tool use to their real-life tasks and thus have ample opportunities to develop a meaningful intellectual partnership with reference tools. Thirdly, the content of training can vary depending on the specific needs of students and the particular set of resources provided, but may include universally applicable principles for successful reference resource consultation, including general strategies to use and pitfalls to avoid, such as the ones identified in this study. Lastly, as an underlying principle, student writers should be reminded of the argument by Salomon et al. (1991) that a mindful intellectual partnership with a cognitive tool requires the human user's active participation. More specifically, students should be taught to abandon the expectation that reference resources work *for* them, helping them to complete the same writing tasks with less time and effort and taught instead to view them as tools that one should work *with* in a cognitive division of labor. In other words, students should realize that the greater autonomy afforded by reference resources comes with a greater responsibility for their own writing and learning.

APPENDIX A

Coding Scheme for Problems and Queries

Name	Description
Problem types	
Confirmatory	The writer has a specific linguistic item in mind or in writing for a meaning she intends to express and tries to confirm whether they match accurately and/or appropriately in a given context.
Compensatory	The writer does not have a clear idea about how to convert her intended meaning into text and tries to extract potential target items from the reference resources.
Query types	
Verification	Performed to verify the presence or frequency of the instances of an item or its lexical, grammatical accuracy, and/or stylistic appropriateness in a given context. Typically prompted by a *whether* question the writer poses – for example, is the adverb *deeply* the most typical collocate of the word *entrenched*?
Elicitation	Performed to elicit linguistic items that match the writer's intended meaning and typically prompted by a *what* or *how* question – for example, what are the typical adverbs that modify the word *entrenched*?
Query purposes	
Simple	Is *X* (a word, phrase, or syntactic pattern) actually used? Can I say *X* in this

confirmation	context? Is *X* typically and frequently used in the given context?
L2 equivalent	What is the L2 equivalent of *X*?
Collocation	Is *X* a typical or appropriate collocate of *Y*? What is the most typical or appropriate collocate of *X*?
Intended meaning	Does *X* deliver the intended meaning? What is the accurate meaning of *X* in the given context?
Simple alternatives	What are the alternatives that can replace *X* to avoid repetition?
Upgrading alternatives	What are the alternatives of *X* that are more accurate and appropriate in the given context? How can *X* be better expressed?
Article/determiner	Should *X* be used with an article/determiner?
Argument pattern	What are the typical/frequent object types *X* takes? Does *X* take a noun (phrase), *to* infinitive, gerund, or clause as its object? Is *X* a transitive or intransitive verb?
Noun ending	Should *X* be in the singular or plural? Is *X* a countable or uncountable noun?
Sentence/phrases hunting	How can multiple content words be combined in a sentence? (searching for sentences similar to what the writer is trying to say)
General usage	How is *X* used in sentences? (aimed to discover typical syntactic patterns in which it is used or its collocation)
Register	Is *X* in the right register? (formal/informal or academic/non-academic)
Part of speech	Is *X* a noun (or a verb, etc.)? Which word class does *X* belong to?
Spelling	Is *X* spelled correctly? How is *X* spelled?
Others	

Note. Collocations here include both lexical (i.e., combinations among nouns, verbs, adjectives, and adverbs) and grammatical (i.e., verbs, adjectives or nouns combined with a preposition or a grammatical structure) collocations.

APPENDIX B

An Example of a Problem Space

Step		Operations and decisions
Encounter a problem	Initial state:	(…) more *devastating images* and videos of youth culture and life have been produced and shared online (…)
Define and represent the problem		Do native speakers use the phrase *devastating images* in the way I used it in the given context?
Devise a search strategy (Query 1, initial query)	Resource: Query term: Query syntax:	Google *devastating images* Use “” to get exact matches
Perform the query		Click the Google tab of RS and type in *“devastating images”* in the search box
Evaluate the query	Query results:	- (…) *devastating images* of Texas’ drought (…)

results		- (…) *devastating images* of eco-disasters (…)
	Evaluation:	I intended to mean something like images that make people uncomfortable or irritated, but the results showed that *devastating images* are mostly concerned with natural disasters. So I decided to perform another query.
Query 2 (subsequent query)		
Devise a search strategy	Resource: Query term:	COCA *devastating images*
Evaluate the query results	Query results:	- (…)broadcast the *devastating images* and angry reaction from the scene (…)
	Evaluation:	Here too the example showed that it is more about physical destruction or a disaster, and there was only one instance. So I decided to look for a word that has a meaning closer to what I intended to say.
Query 3 (subsequent query)		
Define and represent the problem		What are the words that are similar in meaning to *devastating*?
Devise a search strategy	Resource: Query term: Query syntax:	COCA *devastating* [=devastating] ([=word] is a query operator used in COCA that returns the synonyms of the word)
Evaluate the query results	Query results:	- *overwhelming, disturbing, shocking, harmful, destructive,* (…)
	Evaluation:	The word *disturbing* seemed the closest to what I intended to say. So I wanted to search for *disturbing image* as the next query.
Query 4 (subsequent query)		
Define and represent the problem		Do native speakers use *disturbing images* in the context I intended?
Devise a search strategy	Resource: Query term:	COCA *disturbing image*
Evaluate the query results	Query results:	- Rated PG-13 for intense violent thematic material and *disturbing image*s (…) - (…) included several *disturbing image*s of women being victimized by (…)
	Evaluation:	This matched what I intended to mean. And there were also many more instances than *devastating images*. So I decided to replace *devastating* with *disturbing.*
Apply the solution found to the writing	Goal state:	(…) more *disturbing images* and videos of youth culture and life have been produced and shared online (…)

Note. This specific example is from Yumee's data.

NOTES

1. CSE is a customizable search engine that searches websites or URLs sharing specific patterns designated by the user. I created 5 CSEs that search websites of major journals in each participant's field of study and added them to RS. (Two participants were from the same academic discipline, so they shared the same CSE.)
2. The concept of problem space in psychology refers to all the states and steps a problem solver goes through to reach a desired (goal) state (Anderson, 1995).

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